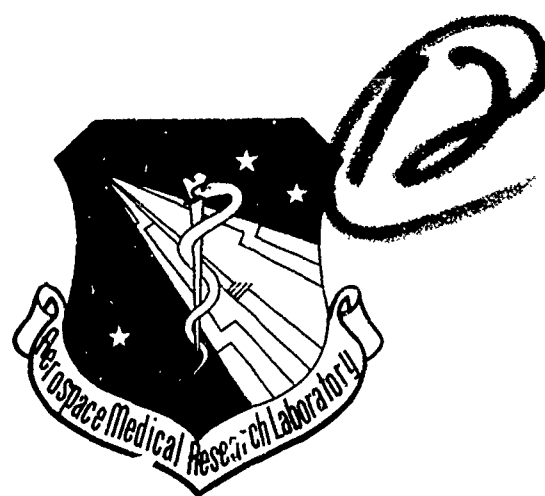


AMRL-TR-75-50
VOLUME 55



ADA029624

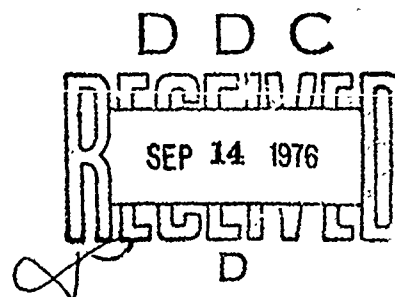
USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

VOLUME 55 AC-130A IN-FLIGHT CREW NOISE

NOVEMBER 1975

Approved for public release; distribution unlimited

AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio 45433



NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Please do not request copies of this report from Aerospace Medical Research Laboratory. Additional copies may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with Defense Documentation Center should direct requests for copies of this report to:


Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314

TECHNICAL REVIEW AND APPROVAL

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER


HENNING E. VON GIERKE
Director
Biodynamics and Bionics Division
Aerospace Medical Research Laboratory

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

009850

ent

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

ACCESSION for	
NTIS	White Section <input checked="" type="checkbox"/>
DDG	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. add/or SPECIAL
A	

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 72310418, Measurement of Noise and Vibration Environments of Air Force Operations. Col Justus F. Rose, Jr. conducted the field measurements and performed the data analysis; Capt Nick Farinacci prepared this report.

The authors acknowledge the efforts of Mr. John N. Cole who established the data analysis requirements and assisted in the preparation of this report, and Mr. Henry Mohlman and Mr. David Eilerman of the University of Dayton who assisted in the mechanics of data processing.

Table of Contents

	<i>Page</i>
INTRODUCTION	3
IN-FLIGHT NOISE	4

List of Tables

1. Measurement Locations and Test Conditions for Noise Measurements	5
2. Measured Sound Pressure Level Octave Band	6-7
3. Measures of Human Noise Exposure	8-9

INTRODUCTION

The AC-130A is a USAF close-support conversion of the C-130A medium-range combat transport aircraft manufactured by the Lockheed Aircraft Corporation, Lockheed-Georgia Company. Power is provided by four T56-A-9 turboprop engines rated at 3,750 eshp at 13,820 rpm maximum take-off power. Each engine drives an Aeroproducts three-blade constant speed, 4.6 m diameter propeller through a 0.074 gear reduction. The engines are manufactured by the General Motors Corporation, Allison Division.

This volume provides measured data defining the bioacoustic environments produced inside this aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the AC-130A aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and aerospace ground equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, aerospace ground equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Refer to *Volume 1* (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

-
1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a standard-configured AC-130A aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard AC-130A environments, but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at various flight crew and passenger locations, with the front door removed, the rear ramp down, the overhead door up, and all internal insulating material removed. However, the rear ramp was up and the overhead door was down when data were collected at No. 5 seat, Forward Compartment. The "doors open" condition (normal flight condition), coupled with the openings in the side of the aircraft where each weapon protrudes, creates airflow of up to 10 knots in velocity inside the cargo compartment at various locations. The wind direction is random and is affected partially by the attitude of the aircraft. A windscreen was used for all data runs to significantly eliminate the turbulence that normally would be generated around the microphone and would otherwise appear in the data as relatively low frequency noise. Table 1 lists the measurement locations and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

The microphone position was at ear level external to headgear in a region 0.2-0.3 meters from the head when an individual was present. At unoccupied locations, measurements were made at ear level throughout a volume where the head would normally be located. In both cases, the microphone was randomly moved throughout a spherical volume approximately 0.3 meter in diameter and the resultant samples analyzed using a 4- or 8-second integration time to obtain a power-averaged level that effectively smooths out short-duration fluctuations and best describes the exposure.

Although the presence of a crew member or passenger at a measurement location affects the resultant sound field, the magnitude of such effects is generally small and not significant in determining exposure limits or voice communication capabilities. Consequently, no distinction is made in this report between occupied and unoccupied measurement locations.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the AC-130A aircraft at the 15 specified locations. This table includes the overall and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These variety of measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS

AC-130A, Rickenbacker AFB, 18 Sep 1968, Serial #54-1623/
Eglin AFB, 23 Sep 1968, Serial #54-1625

LOCATION	POSITION	HEIGHT ABOVE DECK
1	Pilot's Station	Seated Head Level
2	Navigator's Station	Seated Head Level
3	NOD Operator's Station	Seated Head Level
4	Scanner's Station	Seated Head Level
5	Scanner's Station, Hatch Removed	Seated Head Level
6	#2 Seat in Forward Compartment	Seated Head Level
7	#3 Seat in Forward Compartment, Scanner's Hatch Removed	Seated Head Level
8	#5 Seat in Forward Compartment	Seated Head Level
9	Forward Gunner's Station	1.5 Meters
10	Aft Gunner's Station	1.5 Meters
11	Aisle Adjacent to #1 and #2 7.62 mm Miniguns	1.5 Meters
12	Adjacent to Rear Door	1.5 Meters
13	Illuminator Operator's Station	1.5 Meters
14	Radar Operator's Station, Inside Booth, Door Open	Seated Head Level
15	Radar Operator's Station, Inside Booth, Door closed	Seated Head Level

CONDITION*

DESCRIPTION

A	Taxi Power
B	Takeoff Power
C	Climb Power
D	Cruise — 150 KIAS, 2500 ft PA.
E	Cruise — 150 KIAS, 2500 ft PA, #2 Minigun Firing.
F	Cruise — 150 KIAS, 2500 ft PA, #1 and #2 Miniguns Firing.
G	Cruise — 150 KIAS, 2500 ft PA, #1 and #2 Miniguns Firing at Fast Rate.
H	Cruise — 150 KIAS, 2500 ft PA, #1 and #2 Vulcan Guns, and #1 and #2 Miniguns Firing.
I	Cruise — 150 KIAS, 2500 ft PA, #4 Vulcan Gun Firing.
J	Cruise — 150 KIAS, 2500 ft PA, #4 Vulcan Gun and #2 Minigun Firing
K	Cruise — 150 KIAS, 2500 ft PA, #4 Vulcan Gun, and #3 and #4 Miniguns Firing
L	Cruise — 150 KIAS, 2500 ft PA, All Weapons Firing.
*	Aircraft flown with the front door removed, the rear ramp down, overhead door up, and all internal insulating material removed. This applies to all measurement locations except Location 8 at which the rear ramp was up and the overhead door was down.

Firing Rates:

7.62 mm Minigun — 3000 rounds/min except Condition G which was at 6000 rounds/min

20 mm Vulcan Gun — 2500 rounds/min

[illegible]

2

TABLE: MEASURED SOUND PRESSURE LEVEL (DB) OCTAVE BAND													
2													
NOISE SOURCE/SUBJECT: (OPERATION:) IDENTIFICATION:)													
AC-130A GUNSHIP () OMEGA 3.2													
INFLIGHT NOISE LEVELS () TEST 68-015-0n1													
() RUN 02													
() 12 DEC 74													
() PAGE F2													
LOCATION/CONDITION													
FREQ (HZ)	10/D	10/E	10/I	10/J	10/K	11/D	11/F	11/G	11/L	12/D	13/D	14/D	15/D
31.5													
63													
125													
250													
500													
1000													
2000													
4000													
8000													
16000													
OVERALL	112	122	132	131	136	116	130	133	139	119	115	110	109

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE										IDENTIFICATION:	
3											
NOISE SOURCE/SUBJECT: (OPERATION:)										OMEGA 3.2	
AC-130A GUNSHIP										TEST 68-015-001	
INFLIGHT NOISE LEVELS										RUN 01	
										27 APR 76	
										PAGE H1	
LOCATION/CONDITION											
1/D	2/D	3/D	3/H	4/D	5/D	6/F	7/D	8/A	8/B	8/C	9/H
HAZARD/PROTECTION											
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR											
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR											
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)											
NO PROTECTION											
OASLC	109	112	122	136	122	128	133	116	110	119	121
OASLA	95	96	104	132	103	113	132	105	102	104	106
T	71	60	15	P	18	3.2	P	13	21	15	11
HGU-2A/P HELMET WITH H-154											
OASLA*	92	93	101	123	100	108	119	99	95	101	102
T	120	101	25	P	30	8	P	36	71	25	21
HGU-2A/P HELMET WITH H-154(A)											
OASLA*	87	89	98	118	97	104	113	94	90	97	99
T	285	202	42	P	50	15	3.2	85	170	50	36
AMERICAN OPTICAL 1700 EAR MUFFS											
OASLA*	81	85	95	107	95	102	104	90	83	92	94
T	807	404	71	9	71	21	15	170	571	120	85
V-51R EAR PLUGS											
OASLA*	74	76	85	108	84	91	107	81	79	83	85
T	960	960	404	8	431	143	9	807	960	571	404
H-157 IN-FLIGHT COMMUNICATION UNIT											
OASLA*	85	88	97	114	97	104	110	93	87	95	96
T	404	240	50	2.7	50	15	5	101	285	71	60
COMMUNICATION											
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)											
PSIL	88	89	97	126	95	104	127	97	96	96	99
ANNNOYANCE											
PERCEIVED NOISE LEVEL (PNL IN PNDB)											
PNL	110	112	121	144	121	130	144	120	115	119	121

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.
P ADDITIONAL EAR PROTECTION REQUIRED.
< TIME LIMIT SET TO AVOID WHOLE BODY EFFECTS (WHOLE BODY LIMITS EXTRAPOLATED AT -4 DB PER DOUBLE TIME).

TABLE: MEASURES OF HUMAN NOISE EXPOSURE													
IDENTIFICATION:													
3													
NOISE SOURCE/SUBJECT: (OPERATION:)													
AC-130A GUNSHIP ()													
INFLIGHT NOISE LEVELS ()													
LOCATION/CONDITION													
10/D	10/E	10/I	10/J	10/K	11/O	11/F	11/G	11/L	12/D	13/O	14/O	15/O	
HAZARD/PROTECTION													
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN OBC) AT EAR													
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN OBA) AT EAR													
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)													
NO PROTECTION													
OASLC	111	122	131	139	136	115	129	132	138	113	115	109	108
OASLA	102	121	129	128	135	105	128	132	138	111	112	96	93
T	21	P	P	P	P	13	P	P	P	4.5	3.8	60	101
HGU-2A/P HELMET WITH H-154													
OASLA*	95	109	116	116	121	98	116	119	125	99	99	89	89
T	71	6	P	P	P	42	P	P	P	36	36	202	202
HGU-2A/P HELMET WITH H-154(A)													
OASLA*	90	104	111	111	115	94	110	113	119	95	94	86	86
T	170	15	4.5	4.5	2.2	85	5	3.2	P	71	85	339	339
AMERICAN OPTICAL 1700 EAR MUFFS													
OASLA*	83	93	102	102	106	88	100	102	109	91	86	82	81
T	571	101	21	21	11	24	30	21	6	143	339	679	807
V-51R EAR PLUGS													
OASLA*	79	95	104	103	109	81	103	107	112	85	85	74	72
T	960	71	15	18	6	807	18	9	3.8	404	404	950	960
H-157 IN-FLIGHT COMMUNICATION UNIT													
OASLA*	87	100	108	107	112	92	106	109	116	93	91	84	83
T	285	30	8	9	3.8	120	11	6	P	101	143	430	571
COMMUNICATION													
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)													
PSIL	97	115	124	123	129	98	123	126	132	103	104	90	85
ANNOYANCE													
PERCEIVED NOISE LEVEL (PNL IN PND8)													
PNL	115	133	142	141	148	119	140	143	151	126	127	111	108

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.
P ADDITIONAL EAR PROTECTION REQUIRED.

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION